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ABSTRACT

A program was developed to infuse technology into drafting strategies to enhance learning of 11th- and 12th-grade students in a middle-class community in central Illinois who exhibited signs of inadequate achievement related to technology use. To document the extent of students' lack of understanding technology, surveys regarding attitudes toward computer usage and a pretest to assess knowledge of drafting were administered during the first week of the school year. Analysis of probable cause data--site based and from a literature review--revealed that use of technology in drafting without proper computer literacy skills could lead to technological oversimplification. Professionals reported that students lacked the understanding of the role of technology in their learning and that they did not see the relevance of using technology for transfer to real life. A review of solution strategies suggested by knowledgeable others, combined with an analysis of the problem setting, resulted in the selection of five strategies to increase student achievement. The strategies required the students to create projects that were tied to the real world and whose creation incorporated several intelligences. Two other strategies had the students act as peer reviewers and infused computer-aided drafting (CAD) into the rest of the strategies. Post-intervention data indicated an increase in student knowledge and skills of drafting through technology use. (Appendixes include instruments and AutoCAD tutorial lessons.) (YLB)

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IMPROVING STUDENT DRAFTING KNOWLEDGE AND SKILLS THROUGH THE USE OF TECHNOLOGY

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Abstract

This report describes a program for infusing technology into drafting strategies in order to enhance student learning. The targeted population consists of eleventh and twelfth grade students in a middle class community, located in central Illinois. The problems related to the use of technology in the learning process will be documented through observation checklists, project analysis, and teacher made tests.

Analysis of probable cause data revealed that the use of technology in drafting without proper computer literacy skills could lead to technological oversimplification. In general, professionals report that students lack the understanding of the role of technology in their learning and they do not see the relevance of using technology for transfer to real life.

A review of solution strategies suggested by knowledgeable others, combined with an analysis of the problem setting, resulted in the selection of five strategies to increase student achievement. The strategies require projects created to be tied to the real world and that several intelligences should be incorporated in the creation of those projects. Two other strategies will also be used which are to have the students act as peer reviewer and to infuse CAD into the rest of the strategies.

Post intervention data indicated an increase in student knowledge and skills of drafting through the use of technology.

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CHAPTER 1

PROBLEM STATEMENT AND CONTEXT

General Statement of the Problem

The students of the targeted high school exhibit signs of inadequate achievement related to the use of technology. Evidence for the existence of the problem includes teacher observation of technological simplification (i.e., a lack of understanding concerning the processes and role of technology in learning) and class projects that involve some aspect of technological employment.

Local Setting

Student Demographics

A quick comparison of the district and high school demographics presented in Table 1 will confirm that the high school is basically a microcosm of the district.

Table 1

Student Demographics of the District and High School

	District	High School
Total Enrollments	967	307
White	98.4%	98.4%
Black	1%	1%
Hispanic	3%	.3%
Asian/P. Islander	.3%	.3%
Native American	0%	0%
Low Income	3%	3%
Limited-English-Proficient	0%	0%
Dropouts	0%	0%
Attendance	97%	96.7%
Student Mobility	5.2%	3.3%
Ave Class Size	22.2	22.2

A summary of the student demographics of the targeted high school manifests a number of important distinguishing and defining characteristics. First, the population is almost entirely White in terms of race. Second, only 3% of the constituents are considered to have come from "low income" families. Third, student mobility is relatively low. Last, the attendance rate is relatively high.

Staff Demographics

Table 2 juxtaposes the staff demographics of the district with the staff demographics of the high school for the 1996-97 school year. However, more recent trends in the staff demographics at the targeted high school for the 1997-98 school year are the following. First the targeted high school hired five new teachers (replacing four regular positions and adding one new position) for the 1997-98 school year. This means that 20% of the staff are new to the high school. Considering the relative stability of teacher employment at the school, this type of turnover is somewhat of an anomaly. Second, in terms of teachers with master's degrees, the current demographics of the targeted high school do not show that eight high school teachers are currently enrolled and working on getting their master's degrees. This too, will change the demographics of the targeted high school in a notable manner.

Table 2

Staff Demographics of the District and High School

	District	High School
Teachers with Bachelor's Degree:	60.2	16.5
Teachers with Master's & Above:	39.8	11
Average Teaching Experience:	15.3 Years	12.98
Pupil-Teacher ratio:	14.6:1	10.9/1
Pupil-Admin Ratio	214.9-1	200/1

Facility

The targeted high school is part of a unit district comprised of an elementary school and a building that houses the junior high and high school. Although the junior high and high school share the same library and cafeteria, they each have their own classrooms in separate parts of the building. The junior high is in the east third of the building and consists of ten core classrooms, one computer lab, and a special education facility. The high school is in the west two-thirds of the building and consists of 13 core classrooms and the following additional facilities: a technology center with four educational areas and a distance learning lab, one family consumer science lab, two gymnasiums, two technology education labs, one art lab, two science/biology labs, a band and chorus facility, a special education room, and a reading resource center. This building also contains the district, guidance, junior high and high school offices. Due to their different schedules and locations, the high school and junior high students stay basically separated from each other throughout the day.

Academic Program

Students in the graduating class of 1998 must earn a minimum of 27 credits in order to graduate from the targeted high school. Three credits must be earned in English, three credits in mathematics, two credits in science, one credit in recent American History, one credit in Modern American History, one credit in World History, one-half credit in Contemporary Issues, one-half credit in Consumer Economics, one-half credit in Health, one-half credit in Speech, one-half credit in Driver's Education, one-half credit in Keyboarding, one-quarter credit for community service, and one-quarter credit in Physical Education.

One distinguishing characteristic of the targeted high school's academic requirements is its community service course. The community service requirement generates one-quarter credit towards graduation and requires that each student work in an approved program of 40 hours during their four-year high school career.

Required subjects are usually earned in the following years. Freshmen students must take English, mathematics, science, Computer Applications, Modern American History, Health, and Physical Education. Sophomores must take English, mathematics, science, World History, Speech, Drivers Education, and Physical Education. Juniors must take English, Recent American History, and Physical Education. Seniors must take Resource Management, Contemporary Issues, and Physical Education.

The targeted high school employs the eight block scheduling system. The eight block is a schedule based on an A-B day scheduling. Each day has four periods lasting 85 minutes along with a 25-minute activity period each day. An activity period is used for meetings for clubs and study time. The activity period is also used for students to "catch up" with their homework, if they missed a day of class.

The targeted high school offers a variety of vocational classes including Home Economics, Industrial Technology, and business courses. In many of these courses, the targeted high school has an articulation agreement with the local community college in these areas.

Students at the targeted high school have several opportunities to obtain college level credit while still in high school. The targeted high school offers distance learning to its students and to other area high schools via fiber optics and the local community college. Students at the targeted high school have the opportunity to take college level

entrance English classes, which are offered as part of the high school English sequence. Through distance learning, students may also obtain high school credit in program areas that are not offered by the local district.

The targeted high school has a Tech-Prep Team that has been instrumental in designing and implementing several Education-To-Career programs. The targeted school has a large number of students involved in school-to-work programs as well as extra curricular activities.

The Surrounding Community

The school district serves a rural area encompassing 67.25 sq. miles. The village of 2,200 serves as the primary community. The total population the district serves is approximately 6,000. The district buses 66% of its student population of 967.

The targeted community is a rural town of 2,200 located in Central Illinois just 15 miles from the Peoria Metropolitan area. The community is a blend of farm and suburban bedroom communities. The rural population still outnumbers the village population by about 350, but only 8% of the community rely on agriculture for employment. There are 1,680 households within the targeted school district with 808 of the households located within the village. Recent demographics indicate that 56.9% of these households are made up of one or two people. Approximately 47% of the households have children under the age of eighteen. About 34% of the households have occupants 65 or older. A noteworthy statistic is the fact that 81% of the students of the targeted district live in traditional two-parent homes. Furthermore, 96% of these homes have at least one parent employed. About 52 % of the people in the community work in white-collar professional and technical areas (see Table 3).

Table 3

Community Demographics

Community Demographic	Statistic
Household Income	
Median Household Income:	$36,320
Income Less than $25,000:	32%
Income between $25,000-75,000:	60%
Income over $75,000:	8%
Employment	
Professional & Technical:	52%
Laborers:	16%
Craftsmen:	14%
Service:	10%
Farming:	8%
Family Employment	
Both Parents Employed:	49%
One Parent Employed	47%:
Both Parents Unemployed:	4%
Education	
College Degree:	15%
High School Diploma:	66%
No High School Diploma:	19%
Culture	
White Population	5,332
Black Population	0
Asian Pacific Islander Population	5
Hispanic Population	50

The community is considered to be rural and agricultural, yet 52% of the people are professional and technical employees. Farmers make up only 8% of the population (see Table 3). The fact that 92% of those employed are employed outside of farming

indicates the community is changing from a rural community to a more suburban community.

Culturally, the population is clearly a Caucasian community as 98% of the population falls into this category. The Hispanic population makes up the largest minority group within the local community, but it is relatively small (see Table 3).

School Community Issues

In an interview with the principal of the targeted high school, the following issues were discussed as issues that have some bearing on the targeted high school.

The familial and religious composition of the community is beginning to change. What was once a community with a majority of Apostolic Christians and traditional two-parent families is beginning to become a community with multi-religious influences and single parent families.

A proposed tax cap for the county is also a concern. The targeted high school administration feels this will restrict the school's available monies if passed. Present resource monies must be spent carefully at this point in case the voters pass the tax cap.

Teacher turnover is very limited at this targeted high school as evidenced by the average teaching experience of 15.3 years. Fewer turnovers show that the targeted district is well established and is a relatively desirable school in terms of employment.

The targeted high school is open to employing new ideas and proven educational strategies. The eight-block has been put in place, many teachers are obtaining their master's degrees, and the district has one of the best computer/distance learning labs in the area.

The fact that the housing costs are relatively high within the community causes a restriction on what socio-economic groups are able to move into the community.

Technology is valued at the targeted school district. For example, the targeted high school recently constructed a new technology center and hired a technology coordinator. In addition, the elementary school has a computer lab with a software specialist, while the junior high has its own computer lab with a part-time lab supervisor. Amazingly the targeted district has been able to keep its technology labs on the cutting edge while keeping educational spending in check.

National Context

The fact that many schools across America are focusing on implementing technology in the learning process can be easily documented. Indeed, President Clinton has endeavored to make the issue of acquiring computer technology for public schools a national priority (Knickelbine, 1997). In addition, American businesses are increasingly demanding that students come to work with previous experience with computer technology (Fulton, 1998). Since one could argue that the ultimate goal of education is to equip students for successful lives in the world of work, high schools and colleges feel pressure to provide a variety of technological opportunities for students. Hence, many schools are spending an increasing amount of money to equip computer labs with the latest high-powered computers and software in order to meet the expectations of the public and businesses (Knickelbine, 1997).

Though the current zeitgeist in American public schools could be likened somewhat to a technological gold rush, few educational pundits seem to be asking the more difficult questions about the pedagogical effectiveness of computer technology as

measured by student achievement. Since student achievement is at the heart of all well-reasoned educational endeavors and is inextricably bound up with the success of the school, computer technology must be assessed, at least in part, on its effectiveness to facilitate student achievement. Unfortunately, many people erroneously equate the employment of computer technology with student achievement. The fact of that matter is that when students use computer technology it does not automatically translate into higher student achievement. Debra Vaidero (1997), in an article in Education Week, cogently argues this precise point when she writes, "Many educators are banking on the belief that technology improves student achievement. In reality, though, research on its effectiveness offers, at best mixed results" (p. 12). Contrary to popular opinion, the research on the impact of computer technology on student achievement shows both failures and success.

A recent study of one school district in Michigan showed that student achievement actually declined when computer technology became widely available.

> In 1995 the Detroit Free Press reported that Michigan Educational Assessment scores in the Romulus, Michigan, school district dropped to rank near the bottom of the metro Detroit districts. The decline came after a three-year, $24 million investment in computerized integrated learning systems. (Knickelbine, 1997, p. 71)

Furthermore, a recent study done to assess the effectiveness of a three-year, 14.1 million dollar investment by five New York counties showed that the schools' investment in computer technology did not significantly facilitate student achievement (Knickelbine, 1997). Studies like these demand that the cost effectiveness of implementing computer tchnology in education be thoroughly investigated.

Nevertheless, other studies show more positive results of computer technology on student learning. One recent study found that students who used computers to solve mathematical word problems

> did as well as students in traditional classroom at solving standard, one-step word problems. But they were significantly better than children in the control group at solving multistep word problems—the kind of complex reasoning that many education reformers say is so important. (Viadero, 1997, p. 13)

Another recent study of 36 California schools indicated that students who participated in a computer-aided science program "outscored students in traditional classrooms on their grasp of some scientific concepts" (Viadero, 1997, p. 13). In addition to these positive findings, some pundits believe that inner-city students have been greatly helped in their learning via computer technology (Viadero, 1997).

While the present state of understanding concerning the effectiveness of computer technology on student achievement is deficient of persuasive and comprehensive evidence (Trotter, 1997), to be sure, the public perception concerning the effectiveness of computer technology on student learning is at a notable high. According to a recent poll conducted by Phi Delta Kappa and The Gallup Organization (1996), many people feel that the employment of computer technology in the learning process in public schools could significantly strengthen education in America. For example, the poll reported that "there are those who feel that greater use of technology is the answer to many of the problems facing the public schools. The public expresses strong support for providing schools with access to global electronic communications systems" (Elam, et al., 1996, p. 53). This report claims that 80% of the survey's respondents think that computer

technology is either very important (41%) or somewhat important (31%). Furthermore, the report states that "teachers place computer skills alongside the three R's, hard work, citizenship, and history and geography as essentials in public school curriculum" (Elam, et al., 1996, p. 53). However, all of the excitement may be premature. After the initial rush of enthusiasm wears off, the philosophers, principals, superintendents, members of the board, teachers, parents, and students must ask the hard, nagging question: Specifically, how does the use of technology in the learning process facilitate student achievement? Perhaps the public school's present infatuation with computer technology needs to be tempered by this poignant and cogent caveat:

> Let's face it: Computers have so far had only a lackluster impact on student achievement in general. If we don't want to see the plug pulled entirely, what is needed is a far more critical and discerning attitude toward computer-based instruction.... Only when demonstrated effectiveness in improving student learning becomes the central criterion...will schools begin to redeem the true promise of educational technology. (Knickelbine, 1997, p. 71)

CHAPTER 2

PROBLEM DOCUMENTATION

Problem Evidence

In order to document the extent of students' lack of understanding technology, student surveys and a pre-test were administered during the first week of the school year.

A student survey (Appendix A) was completed the first week of class to understand students' attitudes towards the usage of computers. Of the students surveyed, 86% have working computers at home. Seventy-two percent generally liked using computers for their education, while only 14% preferred it. The other 14% generally disliked using computers for their education. The survey also inquired about experiences the students had in computer usage. The most common responses were games and word processing. CAD, Internet, and Power Point were the second most common responses. The conclusion from this survey is that even though students have access to computers, recreation is the preferred usage over academics, which could imply students ineffectively use technology.

During the first week of the 1998/1999 school year, the students took a pre-test (Appendix B) to assess their knowledge of drafting. A summary of the overall results and some specific knowledge that was assessed on the pre-test is presented through figures 1-3.

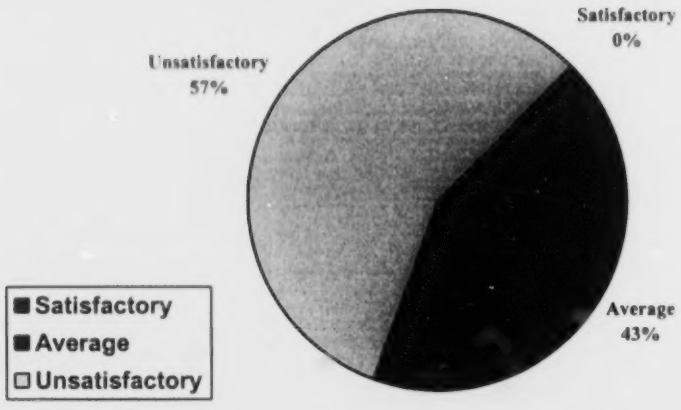

Figure 1. Overall pretest results of the targeted class during the first week of the 1998-99 school year.

A summary of the pretest results is presented in Figure 1. All of the test scores were converted to percentages and placed in either the satisfactory (85 - 100%), average (70 - 84%), and unsatisfactory (0 - 69%) categories. The pretest revealed that 57% of the students' scores fell in the unsatisfactory category and 43% fell in the average category. From the results of the pretest, the researchers found that the students of the targeted class do not have a satisfactory knowledge level of drafting.

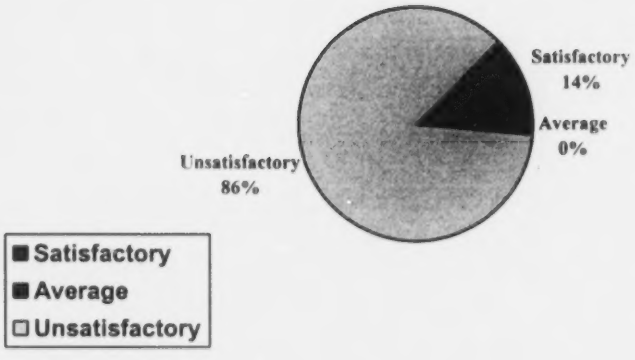

Figure 2. Summary of student knowledge of the alphabet of lines (question two) from the pretest of the targeted class during the first week of the 1998-99 school year.

A summary of the pretest results on the question dealing with the alphabet of lines is presented in Figure 2. This question was part of the total test score, but it was also individually assessed because it is a very important element in the knowledge of all drafting domains. Students had to score either seven or eight points out of the eight possible points on the question to be placed in the satisfactory category; only 14% scored that high. No students scored six or seven points out of eight possible to be in the average category. The other 86% of the targeted students scored five or less points out of the eight to be placed in the unsatisfactory category. This portion of the pretest revealed to the researchers that students' knowledge of the alphabet of lines was very limited.

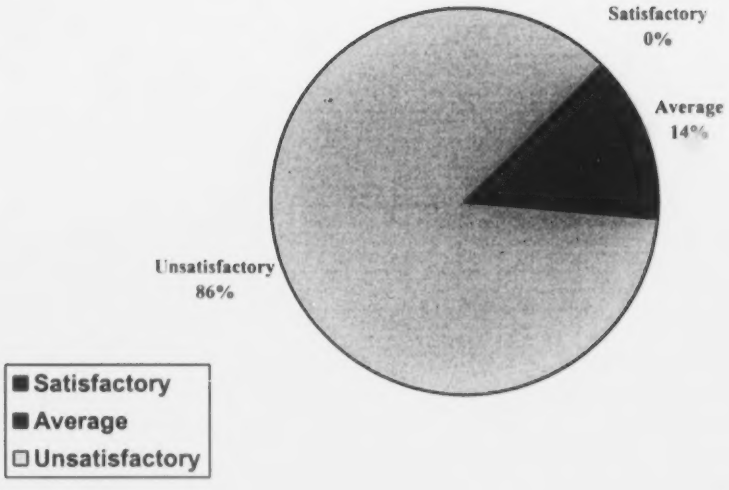

Figure 3. Summary of student knowledge of drafting nomenclature from the pretest of the targeted class during the first week of the 1998-99 school year.

A summary of the pretest results on the question dealing with drafting nomenclature is presented in Figure 3. This question was part of the total test score, but it was also individually assessed because, without adequate comprehension of the nomenclature, the students' learning potential of drafting would suffer. The results show that none of the students scored 9 or 10 points out of a possible 10 points to be placed in the satisfactory category. Fourteen percent of the students scored 7 or 8 points out of a possible 10 points to be placed in the average category. The other 86% of the students scored 6 or less points out of a possible 10 points to be placed in the unsatisfactory category. This portion of the pretest revealed to the researchers that students' knowledge of drafting nomenclature is very limited.

PROBABLE CAUSES

Site-based

After giving the pretest and survey, the researchers found that the students did not have a strong understanding of drafting. There are any number of possible reasons for this lack of understanding drafting. Probably the most obvious possibility would be the students' lack of exposure to the information. Most of the students in the targeted class had not been in any form of a drafting class before. From the survey, the researchers found that the students were not experienced in using computers for educational purposes. Most of the usage was in the forms of games and word processing, not classroom or job based work. This technological oversimplification may interfere with students' academic performance. Another possible cause deals with the problem of student class schedules. Scheduling problems can lead to two possible causes for the lack of knowledge in drafting. The first is that the students that really want to be in the drafting classes because of their interest and background cannot always schedule them because of other requirements that need to be satisfied. The other possible cause is that students that wanted to take another class could not, so they were "forced" to take drafting. Those students that were "forced" may not have the previous experiences that are beneficial to being successful in the class, and they might also be a motivational problem because of lack of interest.

PROBABLE CAUSES

Literature Review

The growing number of books and specialized journals dedicated to the purpose of exploring issues related to the use of technology in education is indicative of the spirit of the times. Presently, much is being said by techno-pundits, and many more voices are rushing to enter the academic conversation that is presently being fleshed-out in writing. The vast amount of literature currently being generated about implementing computer technology into the classroom lucidly manifests multiple factors of causation for

technological oversimplification. A large part of the current research being published concerning the implementation of computer technology in the classroom suggests a bifurcation into two major areas of concern: student issues and teacher issues.

When it comes to student issues and the implementation of technology in learning, many students do not understand the role of technology. Often, students are introduced to computer technology via computer games. According to Debra Viadero (1997), "the most frequent use that 4th graders make of computers is to play games. For 8th graders, playing games is the second most common use, behind writing papers" (p. 15). Consequently, many students perceive computers primarily as a tool for entertainment rather than education--though the two are not necessarily mutually exclusive. Thus, Viadero (1997) warns, "Teachers . . . have to be careful not to let the fun quotient overtake serious learning" (p. 13). Further evidence that students sometimes misunderstand the role of computer technology in learning can be found in a statement by technology researcher Barbara Means. Means cogently laments that some students will spend "a whole period illustrating a color cover of a report, pixel by pixel, when they haven't even done the report yet" (as cited in Viadero, 1997, p. 13). Though many students are enthusiastic about using computers in school, unfortunately, it seems that a considerable amount of students do not yet understand the broader, more important role that computer technology can play in their education.

Another problem that some students encounter when they seek to employ computer technology as a learning tool is the fact that a computer-based learning environment is primarily a self-directed/constructivist approach to education "that places the responsibility for learning on the student" (Umphrey, 1998, p. 4). Tapscott (1998), chairman of the Alliance for Converging Technologies, confirms that, in the computer-based classroom, the role of the student shifts from that of empty vessel waiting to be filled by a teacher's instruction to interactive, engaged learner. This shift can be problematic for some students because they may have been conditioned for years to

function in a more essentialistic/teacher-directed learning environment. The results are both exciting and frustrating for students. Because computer-based learning puts the student in charge of his or her learning, the student often encounters a contradictory sense of empowerment and fear. Tapscott (1998) laments the fact that more often than not, the shift in learning paradigms (from teacher-centered to student-centered) is not done effectively. Though the general consensus of the pundits accentuates the virtues of the interactive learning that happens when students direct their own learning via computer technology, the fact remains that, because of years of conditioning, some students find this new approach threatening--or at least unwelcome. Indeed, the constructivist approach to learning requires students to actually be engaged in authentic higher order thinking, whereas in the essentialistic approach to education, students could often merely parrot back to the teacher whatever they thought the teacher wanted to hear or read. Thus, under this new educational paradigm, students are required to think, work, and learn where before they could simply read, take notes, and regurgitate information back to the teacher in oral or written form. Some students, it seems, are reluctant to engage in self-directed learning via computer technology precisely because it requires them to take responsibility for their own learning.

A second major area of concern related to problems with implementing computer technology into the learning process has to do with issues related to teachers. Unfortunately, many teachers, including many seasoned veterans, have had little or no training in using computers effectively in their teaching. Some teachers even suffer from technophobia--or worse yet, they are hostile toward computer technology. According to Kathleen Fulton, associate director of the University of Maryland's Center for Learning and Educational Technology, computer technology poses a special problem for teachers today: "Technology is a special case. It isn't something teacher's got in their preparation. We assume teachers know about content and pedagogy, and we expect them to stay up to date in those areas. But they have not been prepared to think about how technology can enhance their teaching" (Trotter, 1997, p. 7).

Because of this lack of training, some teachers suffer from technological oversimplification. That is, they have the misunderstanding that if the school provides computers for students to use, then they will automatically engage in learning. However, Stephan Marcus, co-director of the South Coast Writing Project and a researcher at the University of California-Santa Barbara, warns that "to provide a computer and think that students' writing will somehow magically improve--that's just wishful thinking" (Viadero, 1997, p. 13). Furthermore, technology coordinator Stephen Carr gives educators this caveat: "There's a real misconception that you find a piece of software, you put it on, and you let kids play on it. It is just wishful thinking that to provide computers, software, and/or connectivity that learning will magically take place" (as cited in Viadero, 1997, p. 16).

Complicating this problem is the fact that teachers are so busy with their regular teaching duties that they do not have the time for computer technology training. John D. Bransford, professor of psychology at Vanderbilt University, states that "professional development is the biggest bottleneck to the implementation of the new technology in schools, and the reason is that teachers are so busy (Zehr, 1997, p. 26). Indeed, once teachers are certified, they are lucky if they can find the time for any training at all, let alone time for designing integrated technology lesson plans. There is a definite lack of release time for teachers planning for technology that utilizes modern approaches to teaching. Furthermore, Lockwood (1998) confirms that the greatest obstacle to teachers using computers is the lack of time for planning and incorporating such a massive innovation into their practice. So it seems that when it comes to the implementation of computer technology into the classroom, Alfred North Whitehead's words ring particularly true: "Lack of time is the rock upon which the fairest of educational schemes are wrecked" (as cited in Lorber, 1996, p .9).

Another important issue related to teachers is the inevitable shift in the teacher's approach to teaching. In the computer-oriented classroom, the shift is from teacher-

directed education to student-directed education. This is precisely where the traditional essentialistic/teacher-directed philosophy of education comes into direct conflict with the constructivistic/student-directed philosophy of education. This philosophical shift in approach to education has been less than accepted by many veteran teachers. Michael R. Haney, a program director for funding teacher training projects at the National Science Foundation, confesses that he went into teaching years ago because he "liked giving a lecture and having a stage presence" (as cited in Zehr, 1997, p. 24). Haney posits that "We're taking teachers and trying to transform them into something very different than what they signed up for" (as cited in Zehr, 1997, p. 24). Since the employment of computer technology demands that teachers venture away from the traditional, familiar lecture, many veteran teachers immediately feel uncomfortable. Haney further explains his initial frustration with using computer technology in the classroom when he explains, "There was nothing about my [teacher] training that taught me how to have kids go in eight different directions" (as cited in Zehr, 1997, p. 24). Zehr (1997) concurs with Haney and makes it extremely clear when she writes, "Teachers who use technology also must learn how to manage their classrooms differently. They need to become comfortable with different students doing different activities at the same time . . ." (p. 24). The question is whether or not veteran teachers will make the change from lecturing teacher to the guide on the side of the student.

Implementing computer technology into the classroom is not a problem-free task. In fact, employing computer technology in education has created some new, but some would argue, worthwhile problems. As the maxim goes, "You get to pick your problems. You do not get to pick to be problem-free." If computer technology is to be used effectively in education, students and teachers must learn to successfully negotiate the challenges that computer technology presents to them.

CHAPTER 3

THE SOLUTION STRATEGY

Literature Review

The sheer volume of up to date literature has made the task of reviewing the literature on the impact of technology on student achievement both easy and difficult. Finding a technology expert who was willing to share an opinion on the subject at hand was as easy as walking to the school mailbox and sorting through the myriads of journals dedicated to educational technology or doing a simple search on the Internet. However, the volume of articles, journals, and books turned out to be a two edged sword: sorting, classifying, and finding usable material for this project was all the more cumbersome precisely because of the volume. In addition, so much information about the employment of technology in education is currently being discussed that without a constant attempt to keep up with the discussion, one could easily find that relatively "new" ideas quickly become passé. At this point, it is difficult to resist thinking of the researcher as a swimmer trying to keep from drowning in a sea of literature. Wave after wave of documents bring more and more information for the weary researcher to negotiate. The nature of this inundation of literature about computer technology is representative of the current prolific state of technology in our culture.

While the current literature is indeed vast and often unruly, the current zeitgeist of the writing dedicated to implementing computer technology into education is strongly optimistic. At this time, America is riding a strong wave of support for employing computer technology in schools. This is not to say that educational technology does not have its opponents and doubters. However, they currently have a small and relatively insignificant voice in the present academic conversation being conducted via books, articles, and journals. It is probably more accurate to say that at this time in America the two biggest schools of thought concerning the pedagogical value of technology are not

those who believe that computer technology enhances learning and those who do not, but, rather, there are those who are openly endorsing the use of computer technology as an important tool in the learning process and there are those who are cautiously optimistic about how technology is implemented in the educational system.

In the literature, everyone, it seems, offers solutions to the problems that computer technology creates in educational settings. It is common to find almost euphoric anecdotes about how schools are successfully using computer technology in the learning process. Consequently, a number of technology experts have cogent solutions to offer. The following solutions are offered in the context of the specific problems that have already been raised at the end of chapter two concerning student issues and teacher issues.

Since some students do not understand the broader, more important role of technology in learning, they must be systematically trained to understand the role of technology in learning. Indeed, Viadero (1997) stressed the fact that students must be challenged to think of using computer technology to learn rather than solely as a means of entertainment. In *Learning with Technology*, Margaret B. Tinzmann and her colleagues (1997) concurred with Viadero that computer technology in the classroom offers students rich opportunities to enhance learning. Furthermore, Tom King (1997), editor of *Technology in the Classroom*, believed that though technology alone could not make learning success happen, he did not believe that learning success could happen very well unless students had access to the technological tools they needed. He posited that computer technology was an empowering tool that encouraged students to engage in authentic learning. While employing computer technology is clearly not a panacea for pedagogical pathologies, it is an effective tool for learning and all students should be well-aquatinted with any tool that helps them to learn. Therefore, students must be challenged and trained to think of computer technology as a learning tool, not as a tool solely for entertaining themselves.

One possible solution to helping students understand the role of computer technology is to show them how computer technology can prepare them for future employment. According to International Business Machines employee and consultant Harvery Long (as cited in Szabo and Hotch, 1993, p. 1) at least 85 percent of all current jobs involve technology. This kind of pertinent information screams for the attention of educators and strongly appeals to students' seemingly innate need for an education that is relevant and up-to-date. In the 1998 edition of *Learning with Technology*, Educational reformers Robert Kozma and Patricia Schank boldly echo Long's sentiments when they stated that

Students will need to acquire a new set of skills. They will need to be able to use a variety of tools to search and sort vast amounts of information, generate new data, analyze them, interpret their meaning, and transform them into something new. They must have the ability to see how their work fits into the larger picture, to understand how the pieces work together and to assess the consequences of any changes. They must develop the capacity to work with others to develop plans, broker consensus, communicate ideas, seek and accept criticism, give credit to others, solicit help, and generate joint products. (Dede, 1998, p. 4)

The exciting fact is that infusing computer technology into the learning process can facilitate the internalization of the specific skills mentioned by Kozma and Schank (as cited in Dede, 1998). However, for students to perceive computer technology from this broader, more enlightened vantage point, they must be trained to see the computer not merely a means of entertainment, but primarily as a means of learning. Eric Hoffer (as cited in King, 1997) cogently argued that only learners, not the learned, will inherit the future.

Employing computer technology in the learning process also enables many students to take personal responsibility for their own education. While such a proposition strikes fear in the hearts of some students, many others, it seems, welcome the

opportunity to take ownership of their learning. Tapscott (1998) wrote that many in the generation of children growing up in the computer revolution actually prefer to use computer technology as a tool for learning. In addition, Umphrey (1998) noted that the modern learning environment that many new educational software programs help create in schools requires the student to take charge of his or her own learning. According to Viadero (1997), when students move from passive listener to active, engaged learner using technology to process information, student motivation soars. For the most part, the current literature is strongly optimistic about the fact that students who use computer technology in the learning process are self-directed students who are taking responsibility for and ownership of their education. The current literature seeks to substantiate the connection between the use of computer technology and student motivation to learn via anecdotal evidence.

In regard to teacher issues, technology experts are quick to offer multiple solutions. It would be difficult to find anything in the current literature that does not accentuate the need for teacher training. Indeed, technology pundits almost universally agree that teacher training is absolutely basic and critical to the successful implementation of computer technology in classrooms. According to Zehr (1997), at least 30 percent of a school's technology budget should be spent on training for teachers to use computer technology effectively in their classrooms. Zehr further argued that teacher training was most successful when it offered hands-on learning opportunities to explore and when teachers had easy access to equipment and people who could explain how to use computer technology well in the classroom. Clearly, teacher training, in order to be successful, must be extremely practical and readily available. Furthermore, Zehr (1997) pointed out that for teacher training to be truly effective teachers must be involved in planning the training. However, in the real word where the public measures every dollar spent by schools, many schools do not enjoy the luxury of being able to spend 30 percent of the technology budget on staff development. Add to this the fact that teachers

are already pressed to find time for many legitimate educational endeavors and the result is often little or no real effective training for teachers. Nonetheless, Trotter (1997) agreed with the pundits: teacher training is not an option for schools that are serious about successfully infusing computer technology into the learning process. Because teachers stand in the gap between students and the use of computer in the learning process, they will either facilitate or complicate the successful integration of computers in education. Therefore, the literature is pregnant with advice and solutions about how to train teachers to use computer technology successfully in their classrooms.

Another solution offered in the literature in regard to teacher issues has to do with helping teachers cope with the necessary change from the teacher-centered/essentialist approach to teaching to a student-centered/constructivist approach. In *Technology-Based Learning: A Handbook for Teachers and Technology Leaders*, Tweed Ross and Gerald Bailey (1996) wax eloquent when they refer to the fact that the role of the teacher in a technology-rich environment must necessarily shift from being the "sage-on-the-stage" to being the "guide-on-the-side" (p. 22). Zehr (1997) argues that some teachers are simply not willing to make this kind of change in their approach to teaching. Nevertheless, those teachers who are willing to change must embrace at least three different non-traditional teaching roles that Tinzmann and her colleagues (1997) have identified: facilitator, guide, and co-learner/co-investigator. As a facilitator, the teacher's task is to facilitate learning by creating an environment in which students can solve problems, do authentic tasks, and collaborate. As guides, teachers are involved in mediation, modeling, and coaching, especially as students begin their inquiry. As co-learners and co-investigators, teachers are involved in learning right along side of the students. When teachers change their functional educational philosophy to what has been described above, then many of the pundits in the current literature state that these teachers will be in a position to use computer technology effectively in their classrooms.

The subsequent action plan clearly demonstrates a shift in functional educational philosophies (from essentialism to constructivism) that teachers must negotiate if they desire to implement technology effectively in their classrooms. The action plan accentuates key tenets of the constructivist approach to teaching and learning as outlined by Books and Brooks (1993). For example, the first step in the action plan calls for the teacher to gather baseline data. The primary reason for this first step is so that the teacher may facilitate students' learning. Indeed, it behooves the teacher to gather baseline data so that he might be able to intelligently create a learning environment where students can function as inquirers and construct their own knowledge (Joyce and Weil, 1996). Furthermore, the following action plan calls for the teacher to function as a guide. The action plan calls for the teacher to guide students in a self directed learning journey using technology to achieve specific content objectives. The computer lab serves as the location in which the teacher guides students by modeling and coaching students as they employ various aspects of technology to learn. Finally, the action plan shows that the teacher is co-learner with the student. The fact is that the action plan is designed to help the teacher to learn about how to effectively help students achieve via computer technology. The action plan calls for the teacher to write reflective logs and to gather post-intervention data so that the teacher can gain insights into teaching, students, and using technology in the learning process. Clearly, then, the action plan, though it contains some elements of essentialism (i.e., direct instruction), is rooted in constructivism.

Without a doubt, the infusion of technology into the American classroom creates new problems. However, there is a plethora of literature about how to solve virtually every problem that could possibly be encountered. The literature about employing computer technology into classrooms is saturated with solution-oriented articles and books. What remains to be seen is whether or not the solutions offered by many pundits in their euphoric anecdotes can be generalized to different school systems throughout the country.

Project Objectives and Processes

As a result of infusing technology into the learning process, during the period of September 1998 to February 1999, the eleventh and twelfth grade students from the targeted class will increase their knowledge of drafting strategies, as measured by teacher-constructed tests, observation checklist, and project analysis.

In order to accomplish the project objective, the following processes are necessary:

1. Several topics in the class will be tied to real world applications.
2. Projects will be created to enhance the learning of the information for the students.
3. Throughout the course, the students will use peer review and collaboration to check each other's understanding of the information.
4. Several activities will incorporate multiple intelligences.
5. Computer Aided Drafting techniques will be infused into processes 1-4.

Project Action Plan

To better evaluate the progress of students in the targeted class, they will be evaluated and observed repeatedly throughout the implementation of the intervention. There will be an observation checklist completed bi-weekly, and all projects will be evaluated upon completion using the same grading rubric. Team teaching will also occur throughout this research project.

I Pre-test

Week 1: A. A pre-test will be administered before the first day of instruction to check the students' base knowledge of drafting strategies, and to check their knowledge of computer usage and its role in education. (September 1998)

II CAD Instruction

Week 2: A. Identify system parts.

1. Input devices.

2. Output devices.

Week 3: B. Software usage.

Week 4: C. Through the use of the AutoCAD tutorial (Conner 1995), the students will learn the proper use of CAD tools that will be used in the rest of the action plan.

Week 5: D. Through the use of peer review and collaboration, the students will identify the alphabet of lines. (Appendix C; Sample Lesson)

1. Proper drawing techniques.

2. Proper use in drawings.

Week 6: E. In the real world, the American National Standard Institute mandates proper lettering techniques.

1. Letter forms.

2. Techniques used to create letters.

3. Proper labeling using lettering.

Week 7: F. Using visual spatial and bodily/kinesthetic intelligences students will learn the geometry needed in CAD. (Appendix D; Sample Lessons)

1. Bisecting Lines.

2. Bisecting Angles.

3. Enlarging Drawings.

4. Reducing Drawings.

5. Identify and Draw different shapes.

III Create projects using CAD.

Weeks 8-9: A. Page layout.

1. Borders.

2. Title Blocks.

3. Centering

Weeks 10-15: B. For a tie to drafting industry, different orthographic drawings will be created using some visual/spatial activities.

1. Two-view drawings.

2. Three-view drawings.

3. Pictorial drawings.

4. Perspective drawings.

5. Section views.

Week 16: C. Dimensioning drawings.

1. Proper lines and styles.

2. Proper use of letters and numbers.

IV Posttest (Appendix E)

Week 17: A. At the completion of the research, the students will take a posttest to check for an increase of the students' knowledge of drafting strategies because of the use of the intervention. (February 1999)

Methods of Assessment

In order to assess the effects of the intervention, tests covering knowledge and skills used in drafting will be developed. In addition, student observation checklists will be completed several times throughout the time of the intervention period. A project grading rubric will be developed to assess the quality of students' projects throughout the duration of the intervention.

CHAPTER 4

PROJECT RESULTS

Historical Description of the Intervention

The objective of this project was to increase student knowledge of drafting strategies through the use of technology. Computer Assisted Drafting techniques were infused into the drafting curriculum to achieve the desired changes.

During the first week of the 1998/1999 school year, the students were given a teacher-constructed pretest and a computer usage survey to establish baseline data for the class. The computer survey was used to assess students' attitudes towards the usage of computers and their role in education. The pretest gave baseline data on the students' knowledge of drafting strategies.

Following the pretest and survey, the students worked on assignments using traditional drafting techniques. The original plan did not include any traditional drafting, but it was felt that the use of it would help clarify students' knowledge of drafting strategies. Observation checklists and project grading rubrics were used to help gather the data from the traditional methodology. The traditional drafting lasted for approximately ten 85-minute class periods, and then the following two weeks were used to assemble a new CAD/Drafting lab that the school had purchased. After the lab was completed, the process of implementing the intervention was started.

The students start using the AutoCAD tutorial (Conner, 1995) to learn the basics tools necessary to perform drafting operations used throughout the intervention. The students then got

into their instructor-assigned groups to review the CAD tools, the alphabet of lines, proper lettering techniques used in industry, and drafting geometry (Appendix C). The groups worked together or with an instructor to help identify and clarify any problems they might have from those activities. To accomplish this, the students worked in their groups for approximately three weeks. To aid in the learning of the geometry, activities using visual/spatial and bodily/kinesthetic intelligences were used. Appendix D gives an example of how those intelligences were used in a lesson. For that lesson, the students did exercises that included bisecting lines and angles, enlarging and reducing drawings, and identifying and drawing different geometric shapes. At this point, the students left their groups to begin individual work on projects.

In the next part of the intervention, students used knowledge gained from their groups to complete their individual project assignments. These assignments included a proper page layout (Appendix F), geometry used to complete orthographic drawings (Appendix G), and dimensioning of those drawings assigned. The visual/spatial activity called the "Glass Box" was also used to help create some of the orthographic drawings (Appendix H). To help clarify results, some of the assignments were the same in both traditional drafting and CAD. Throughout the project portion of the intervention, we completed observation checklists bi-weekly, and each assignment turned in was graded using the assignment-grading rubric.

At the completion of the intervention, a posttest was given to check for an increase in knowledge of drafting strategies.

Presentation and Analysis of Results

In order to assess the effects of technology on student knowledge of drafting techniques, a pretest and posttest were given. These data are compared in Figure 4.

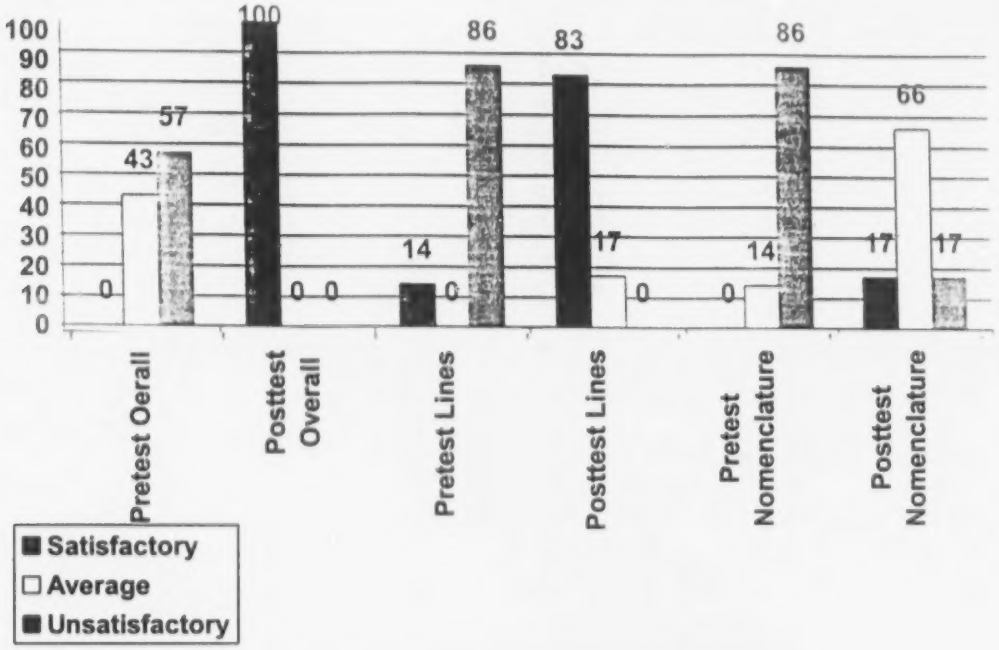

Figure 4. Summary of percentage scores from the pretest and posttest.

The intervention appears to have had a positive effect on all areas of student knowledge as evaluated from the results from the tests. All of the test scores were converted to percentages and placed in either the satisfactory (85 - 100%), average (70 - 84%), and unsatisfactory (0 - 69%) categories. Of particular note are the posttest overall scores; they are all in the satisfactory range. Student knowledge on the alphabet of lines also increased dramatically with scores changing from 86% unsatisfactory to 83% satisfactory and no scores in the unsatisfactory category. The only area that did not have as significant of an increase is the area of drafting nomenclature. The percentage of students at the unsatisfactory ranges did reduce by 69%, but there were only 17% of the scores on the posttest that reached the satisfactory range.

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In order to help document the progress of the intervention, the researchers collected data by completing observation checklists (Appendix I) and using a student assignment-grading rubric (Appendix J). The observation checklist had four different observable skills and were completed before the intervention (traditional drafting), the beginning of the intervention, and at the conclusion of the intervention. The student assignment-grading rubrics had eight different criteria to grade assignments on and were completed on the same timeline as the observation checklists. The data from the checklists is presented in Table 4, and the data from the grade rubrics is presented in Table 5.

Table 4

Percentages from the Observation Checklists of Student Skills

Skills	Traditional Drafting			Beginning Intervention			Post Intervention		
	Poor	Fair	Good	Poor	Fair	Good	Poor	Fair	Good
Lettering	50%	38%	12%	25%	13%	62%	0%	12%	88%
Geometry	11%	45%	44%	0%	13%	87%	0%	0%	100%
Line Weights	22%	78%	0%	0%	100%	0%	0%	35%	65%
Multi-views	0%	45%	55%	0%	0%	100%	0%	12%	88%

Table 4 shows that through the use of the intervention almost every observed skill increased as the intervention progressed. A good example of this progression is the change in the line weights skill. Both the traditional drafting and the beginning of the intervention had scores of 0% for the good range, while the post intervention had 65% in the good range. Another

example is how the observed geometry skill improved throughout the whole intervention process. The scores started at 44% in the good range for the traditional drafting, to 87% at the beginning of the intervention, and ending at 100% at the conclusion of the intervention. The only area that showed a decline through the intervention was between the beginning and ending of the intervention for the multi-view skill. The scores in the good range decreased from 100% to 88%. The reason for the decline in scores may be because the assignments at the end of the intervention were much more difficult than what were used at the beginning. This was expected because the researchers knew that they would have trouble with the harder material; however, it is felt that the students still are more skilled than the scores show when compared to the beginning of the intervention.

Table 5

Percentages of Projects Meeting Grading Rubric for each Criteria

Criteria	Traditional Drafting				Beginning Intervention				Post Intervention			
	Not Yet	Fair	Good	Excellent	Not Yet	Fair	Good	Excellent	Not Yet	Fair	Good	Excellent
Lettering	0%	100%	0%	0%	0%	43%	57%	0%	0%	0%	0%	100%
Centering	0%	60%	20%	20%	0%	0%	100%	0%	0%	0%	71%	29%
Bisecting Lines	100%	0%	0%	0%	0%	33%	44%	23%	0%	0%	71%	29%
Bisecting Angles	100%	0%	0%	0%	0%	23%	54%	23%	0%	0%	44%	56%
Shapes	0%	86%	14%	0%	0%	38%	62%	0%	0%	0%	71%	29%
Proper Line Weight	0%	86%	14%	0%	0%	0%	62%	38%	0%	0%	100%	0%
Proper Dimensioning	86%	14%	0%	0%	0%	0%	100%	0%	0%	0%	86%	14%
Multi-views	14%	57%	29%	0%	0%	0%	86%	14%	0%	0%	71%	29%

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The data collected for Table 5 was collected from project drawings completed by the students during the above mentioned time frame. The projects were assessed based on the criteria listed on the student assignment-grading rubric (Appendix J). The data in Table 5 shows that the students' projects improved as the intervention progressed. An example of this improvement is the increase in student scores on the criteria of lettering from only scoring fair during the traditional drafting to 100% in at the completion of the intervention. Another example of strong improvement is in the multi-view criteria. The majority (57%) of the scores were in the fair category during traditional drafting, and they improved to 71% in the good category and 29% in the excellent category during the completion of the intervention. Table 5 shows a huge increase in the bisecting lines and angle criteria; however, this is not accurate because there were no assignments during the traditional drafting that required those activities. There was a significant increase in those activities from the beginning of the intervention to the completion of the intervention.

Conclusions and Recommendations

Based on the presentation and analysis of the data on drafting strategies, the students showed an increase in drafting skills and knowledge. The researchers believe that the use of technology with drafting greatly improved the success of the students during the intervention. From the researchers' observations, it was evident that students enjoyed the use of the technology during the intervention, which in turn increased their motivation. The use of cooperative groups and multiple intelligences gave both the researchers and students time to ask and answer questions that otherwise would have taken a longer period of time to complete. With the added understanding of the technology, the student involvement, grades, and enthusiasm towards their skills increased. As stated above, the observation checklists and assignment

grading rubrics show remarkable increases in almost all areas. The students involved in the research were also asked to complete a PMI on their experiences they had with the technology. The following are examples of what some of the students stated on their PMIs.

- I believe that computer drafting is better that traditional drafting because it is faster, easier, and more exact.
- The computer finished copy also looks much more professional.
- CAD is a much easier and quicker way to draw up your plans.
- Traditional drafting is easier to make mistakes and harder to correct.

As one can see, both the data and the student PMIs show that there was a strong connection between the use of technology and the improvement in student drafting skills. A large part of that improvement can also be attributed to the fact that the students were more motivated to do the skills when it came time to use the technology, which is an added benefit that was expected but we were not sure of how much it would make an impact.

We, the researchers, have several recommendations to make for future researchers. The primary recommendation we can make is to use a larger body of students from whom to observe and collect data. Along with the larger amount of students, a longer time frame would be beneficial. By the use of the extra data and time, researchers would have a more conclusive end result. A second recommendation would be to use a more diverse group of students. The group that we had to work with were all of the average to above average category. It might be of interest to see if the use of technology would make as large of improvements in lower achieving students as it did with our students. Another recommendation would be to incorporate a broader area of drafting. The research we did was somewhat limited because of the time frame we had to work in.

It is the opinion that the use of multiple intelligences and vary activities increased the motivation of the students. By the use of those during the intervention, a more relaxed atmosphere was created, which allowed the students the freedom to ask questions when needed. With the use of team teaching and mentor help, the student participation and engagement always seemed to be positive which added in the creation of a better learning environment. The researchers have agreed that they will continue to use these strategies in all future classes.

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Appendix A

Student Survey

Name _____

Survey of computer knowledge.

Directions: Circle what you feel is the correct answer for each question.

1. Do you have a working computer at home?

   A. Yes B. No

2. Which of the following best describes your feelings about using computers to learn?

   A. Prefer it B. Generally like it C. Doesn't matter

   D. Generally dislike it E. Fear it F. Frustration

   G. Other:_____

3. Whether at school, home, a friend or relative's house, which of the following activities have you experienced on the computer? Circle all that apply.

   A. Games B. Word Processor C. E-mail

   D. Surf Internet E. Power point F. Made a web page

   G. CAD H. Other:_____

Appendix B

Drafting I Pretest

Name _____

I Short Answer

Directions: Read each question carefully, then provide an adequate response.

1. Identify the following drafting equipment.

A. _____

B. _____

C. _____

D. _____

E. _____

F. _____

G. _____

H. _____

I. _____

J. _____

K. _____

L. _____

M. _____

N. _____

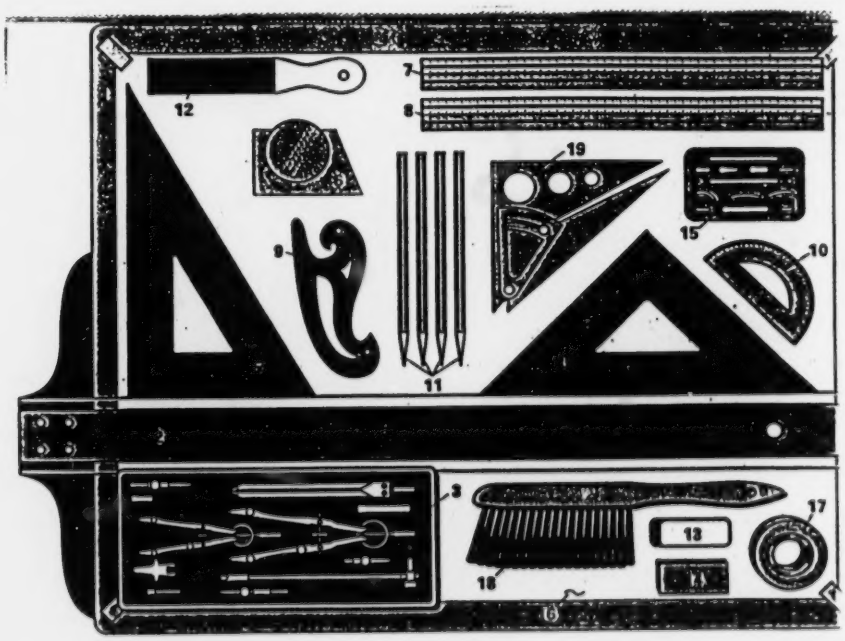
O. _____

P. _____

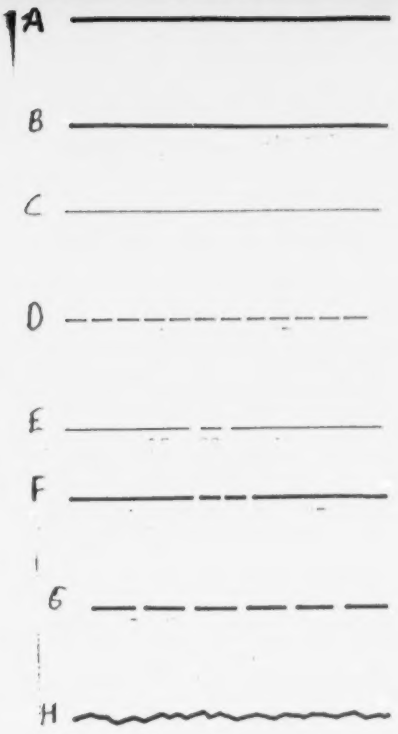
Q. _____

R. _____

S. _____



2. Identify the following line types.



A. _____

B. _____

C. _____

D. _____

E. _____

F. _____

G. _____

H. _____

3. Print the following information using proper Gothic lettering technique.

Name _____

Address _____

Phone Number _____

4. Explain the procedure to center a drawing on a 9" x 12" sheet of paper.

5. Explain the different views of an orthographic drawing.

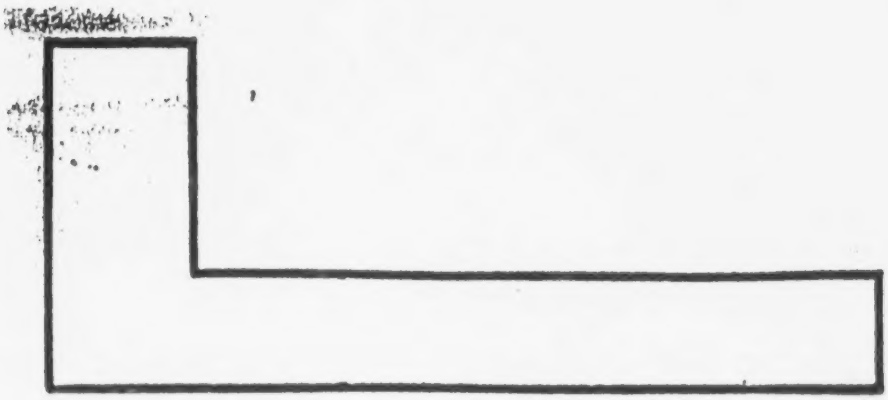
6. Measure the following lines using an architect's scale.

   A. _____ _____

   B. _____ _____

   C. _____ _____

7. Using a ruler and proper dimensioning techniques, properly dimension the following drawing.



II Vocabulary

Directions: Provide the complete definition of the following terms.

1. CAD –
2. Bisecting –
3. Gothic Lettering –
4. Diameter –
5. Tangent –
6. Orthographic –
7. Elevation –
8. Dimension Line –
9. Cutting-plane Line –
10. Mechanical Drafting -

Appendix C

AutoCAD Tutorial Lesson I

Lesson: Drawing and placing lines, and changing linetypes.

Directions: Students are to work in their assigned groups to complete the following activities in the AutoCAD Tutorial.

1. Students work in chapter 1 of tutorial, pages 10-11. The activity is called "Drawing a line." Use steps 1-10 to complete this activity.
2. Students work in chapter 3 of tutorial, page 58. This activity is called "Using object snap quadrant." Use steps 1-7 to complete the activity. This activity is used to place lines in their correct places.
3. Students work in chapter 3 of tutorial, page 65. The activity is called "Loading linetypes." Use steps 1-5 to complete this activity. This activity loads into the drawing all linetypes that could be used. It needs to be done for each drawing that uses multiple linetypes.
4. Students work in chapter 3 of tutorial, pages 65-66. This activity is called "Changing an entity's property." Use steps 1-7 to complete the activity. After you make a drawing, this activity is done to change the linetypes in that drawing. You can change a line to any of the ones that were loaded into the drawing from the previous activity.

Appendix D

AutoCAD Tutorial Lesson II

Lesson: Drawing arc and circles, bisecting lines and angles, and enlarging drawings.

Directions: Students are to work in their assigned groups to complete the following activities in the AutoCAD Tutorial.

1. Students work in chapter 1 of tutorial, page 12. The activity is called "Drawing a circle with the correct radius." Use steps 1-4 to complete the activity. Also on page 12 is the activity "Drawing an arc." Steps 1-4 will complete this exercise.
2. Students work in chapter 3 of tutorial, page 54. This activity is called "Drawing a circle." Use steps 1-4 to complete the activity for bisecting a line to place the center of a circle. The same steps can be used to bisect an angle.
3. Students work in chapter 5 of tutorial, pages 134-135. This activity is called "Inserting and scaling one drawing into another drawing." Use steps 1-8 to complete the activity for enlarging one drawing to the same size and scale as another drawing.

Appendix E

Drafting I Exam

Name _____

I Short Answer

Directions: Read each question carefully, then provide an adequate response.

1. Identify the following drafting equipment.

A. _____

B. _____

C. _____

D. _____

E. _____

F. _____

G. _____

H. _____

I. _____

J. _____

K. _____

L. _____

M. _____

N. _____

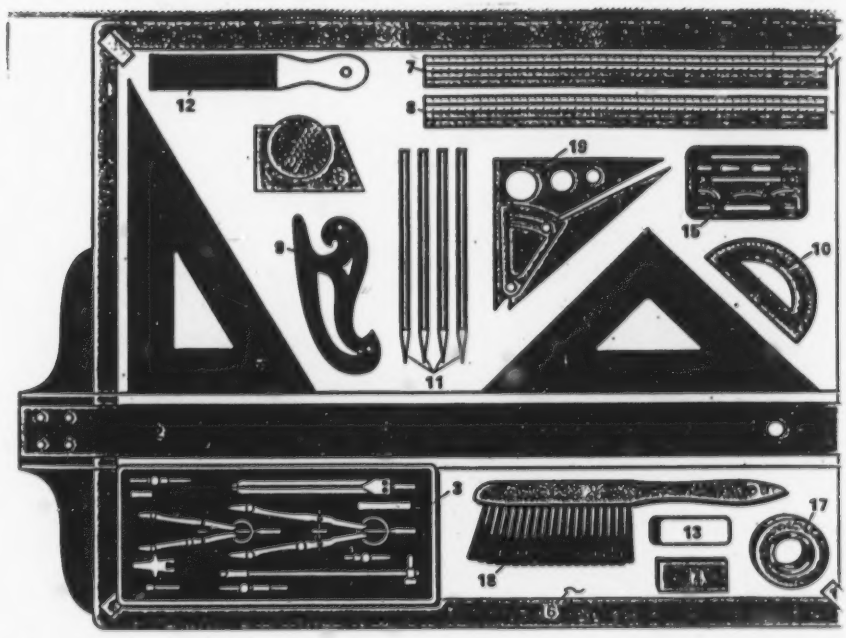
O. _____

P. _____

Q. _____

R. _____

S. _____



2. Identify the following line types.

A. _____

B. _____

C. _____

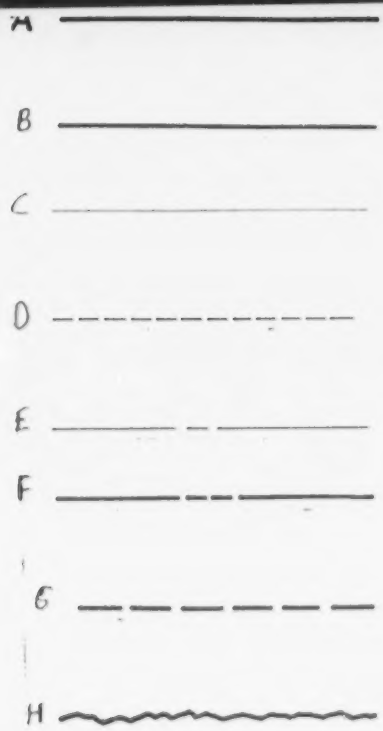
D. _____

E. _____

F. _____

G. _____

H. _____



3. Print the following information using proper Gothic lettering technique.

Name _____

Address _____

Phone Number _____

4. Explain the procedure to center a three view drawing on a 9" x 12" sheet of paper.

5. Explain the different views of an orthographic drawing.

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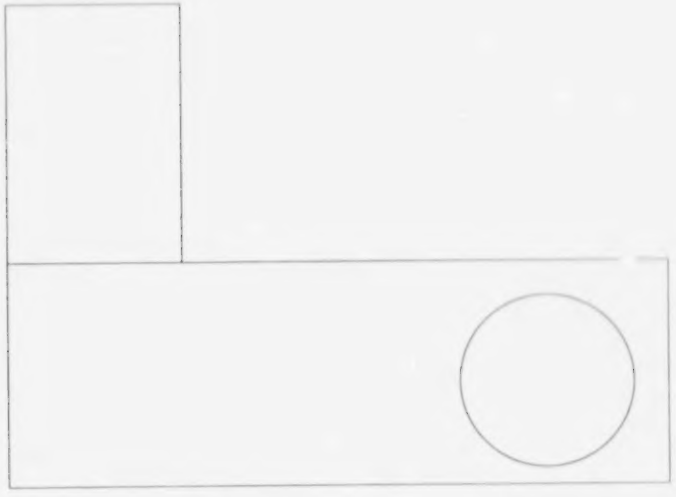
6. Measure the following lines using an architect's scale.

   A. _____ _____

   B. _____ _____

   C. _____ _____

7. Using a ruler and proper dimensioning techniques, properly dimension the following drawing.



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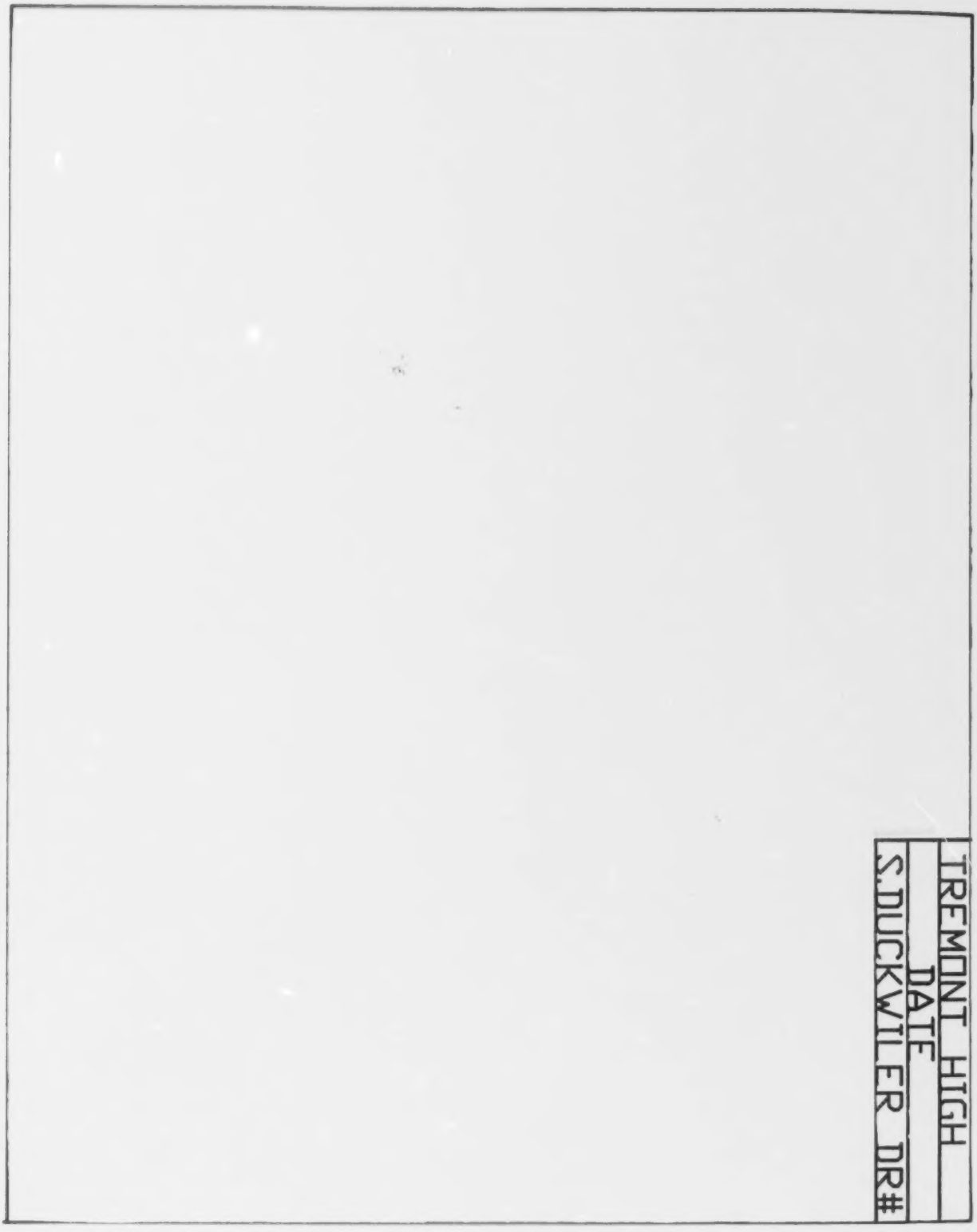
II Vocabulary

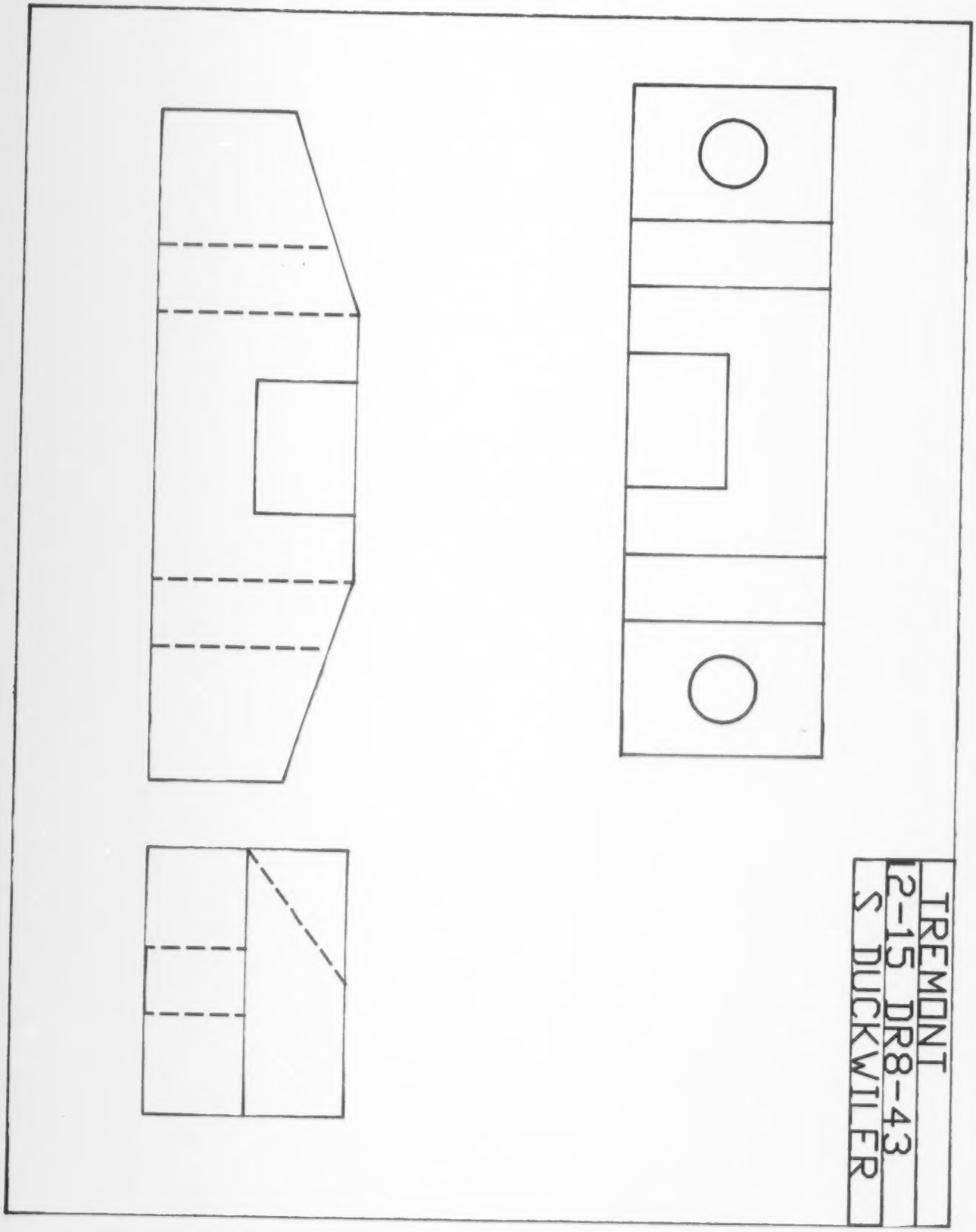
Directions: Provide the complete definition of the following terms.

1. CAD –
2. Bisecting –
3. Gothic Lettering –
4. Diameter –
5. Tangent –
6. Orthographic –
7. Elevation –
8. Dimension Line –
9. Cutting-plane Line –
10. Mechanical Drafting -

Appendix F
Page Layout



Appendix G
Orthographic Drawing



Appendix H
Glass Box

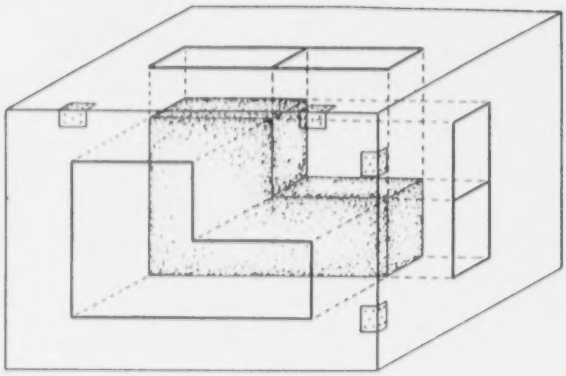
RELATION OF VIEWS

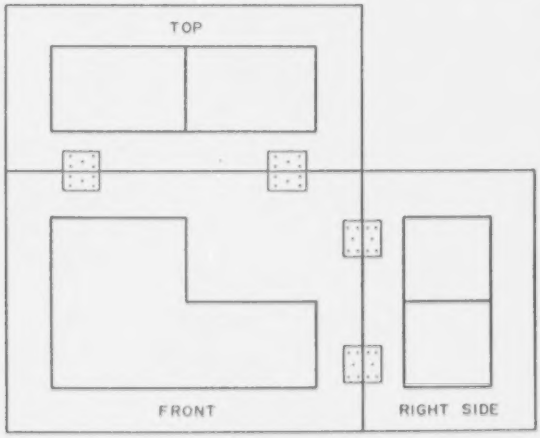
Objective: To describe the relationship of front, top, and side views in orthographic projection.

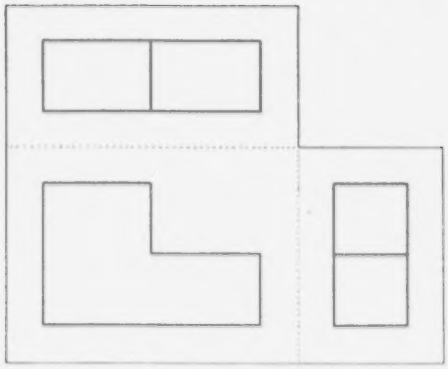
Imagine a block placed inside a glass box. As you look at the box from different directions, you see different views of the block. Each view can be traced on the glass box.

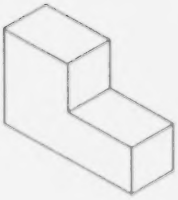
The sides of this box are hinged so that it can be opened to show the relation of the views. When the box is opened, the top view will be directly above the front view. The vertical lines will match in each view. The right side view will be directly opposite the front view. The horizontal lines will match in these two views.

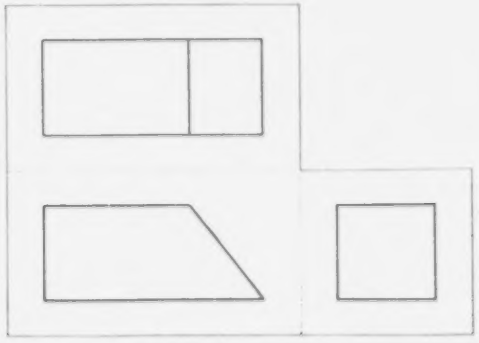
In order to see the relation of views better, trace the drawings below on another sheet of paper. Cut out the drawings and fold on the dotted lines. This will show the views as they would be drawn on the glass box.











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Appendix I

Observation Checklist

Teacher:_____ Class:_____ Date:_____

Ratings:

+ = Good
✓ = Fair
0 = Poor

Names of Students	Lettering	Geometry	Line Weights	Multi-views
1.				
2.				
3.				
4.				
5.				

Comments:_____

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Appendix J

Student Assignment Grading Rubric

Criteria: Scale:	0 = Not Yet	1 = Fair	2 = Good	3 = Excellent
1. Lettering				
2. Centering				
3. Bisecting Lines				
4. Bisecting Angles				
5. Shapes				
6. Proper Line Weight				
7. Proper Dimensioning				
8. Multi-views				

Total Score:_____